## Abstracts & Schedule

Schedule will change as more details become known. Please continue to check back.

### Monday, January 31, 2011

**Dark Matter, Direct & Indirect Tests**

**Organized by:**  
Ina Sarcevic

Well-developed techniques for detection of dark matter now include both indirect astrophysical and direct terrestrial studies. In addition, the latest theoretical ideas on the nature and impact of dark matter continue to evolve. In this session, we will discuss astronomical observations of galaxies and clusters of galaxies, recent astronomical observations that limit baryonic component of the dark matter, and latest results and theories stemming from a series of recent experiments including Fermi/LAT, PAMELA, IceCube, VERITAS, HESS, CogeNet, DAMA.

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<td>7:00 a.m. - 8:30 a.m.</td>
<td>Continental Breakfast</td>
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<td>8:00 a.m. - 8:30 a.m.</td>
<td>Paolo Gondolo (University of Utah)</td>
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<td>8:30 a.m. - 9:00 a.m.</td>
<td>David Cline (UCLA)</td>
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<td>9:45 a.m. - 10:15 a.m.</td>
<td>Mathieu Vivier (University of Delaware)</td>
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<td>9:30 a.m. - 9:45 a.m.</td>
<td>Searching for Daily Modulation in Direct Dark Matter Detectors</td>
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<td>10:15 a.m. - 10:45 a.m.</td>
<td>Proton Size Anomaly</td>
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<td>10:45 am-4:30 pm</td>
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<tr>
<td>4:30 p.m.-5:00 p.m.</td>
<td>Searching for Dark Matter with the Fermi Large Area Telescope</td>
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**Continental Breakfast**

**Overview of the Direct & Indirect Search for Dark Matter**

* I review the status of the current search for Dark Matter (Direct and Indirect) from the results of DM2010, and the other recent meeting. The future search will likely be dominated by various XENON detectors. I will also review the low mass WIMP region for the present and future.

**Indirect Dark Matter Searches with VERITAS**

* In the cosmological paradigm, Cold Dark Matter (DM) dominates the mass content of the Universe and is present at every scale. Candidates for DM include many extensions of the standard model, with a Weakly Interacting Massive Particle (WIMP) in the mass range from 50 GeV to greater than 10 TeV. The self-annihilation of WIMPs in astrophysical regions of high DM density can produce secondary particles including Very High Energy (VHE) gamma rays with energies up to the DM particle mass. The VERITAS array of Cherenkov telescopes, designed for the detection of VHE gamma rays in the 100 GeV-10 TeV energy range, is an appropriate instrument for the detection of DM. Dwarf spheroidal galaxies (dSphs) of the Local Group are potentially the best targets to search for the annihilation signature of DM due to their proximity and large DM content. This presentation reports on the latest VERITAS observations of dSphs and discusses the results in the framework of WIMP models.

**Searching for Daily Modulation in Direct Dark Matter Detectors**

* The channeling of the ion recoiling after a collision with a WIMP in direct dark matter detectors produces a larger signal than otherwise expected. Channeling is a directional effect which depends on the velocity distribution of WIMPs in the dark halo of our galaxy, and could lead to a daily modulation of the signal. I will present estimates of the expected amplitude of daily modulation due to channeling in the data already collected by the DAMA/NaI and DAMA/LIBRA experiments.

**Proton Size Anomaly**

* A measurement of the Lamb shift in muonic hydrogen yields a charge radius of the proton that is smaller than the CODATA value by about 5 standard deviations. We explore the possibility that new flavor-conserving nonuniversal interactions may be responsible for the discrepancy. We consider exotic particles that among leptons, couple preferentially to muons, and mediate an attractive nucleon-muon interaction. We find that the many constraints from low energy data disfavor new spin-0, spin-1 and spin-2 particles as an explanation.

**Mid-Day Break**

**Searching for Dark Matter with the Fermi Large Area Telescope**
The Fermi Large Area Telescope (LAT) is exploring the gamma ray sky in the energy range from 20 MeV to over 300 GeV with unprecedented sensitivity. One of the most exciting science questions that the Fermi LAT will address is the nature of dark matter. I will present recent results on these searches.

Ann Zabludoff
University of Arizona
5:00 p.m.-5:30 p.m.

New Constraints on Old Dark Matter Halos

The distribution of mass in the halos of clusters of galaxies is related to the nature of the dark matter particle. Popular cold matter (CDM) models make specific predictions about the shape of the halo mass profile, which can be altered via the subsequent accretion of gaseous and stellar baryons. Differences among the models are pronounced only within 100 kpc of the core, where observational tests are scarce. A promising method for constraining cluster mass profiles is to use the kinematics of stars in the extended, luminous halo of the central, massive galaxy (aka the "intracluster starlight"). New data suggest that these stars respond to the gravitational potential of the cluster core. Under the assumption of isotropy, the observed kinematics of these stars can be reproduced only if the halo has a softer core, ie, less concentrated mass, than the predictions of current CDM simulations.

Haibo Yu
University of Michigan
5:30 p.m.-6:00 p.m.

Sommerfeld Enhancements for Thermal Relic Dark Matter

The annihilation cross section of thermal relic dark matter determines both its relic density and indirect detection signals. We determine how large indirect signals may be in scenarios with Sommerfeld-enhanced annihilation, subject to the constraint that the dark matter has the correct relic density.

Coffee Break
6:00 p.m.-6:15 p.m.

Ina Sarcevic
University of Arizona
6:15 p.m.-6:45 p.m.

Probing Dark Matter with Neutrinos from the Galactic Center

We calculate the contained and upward muon and shower fluxes due to neutrinos produced via dark matter annihilation or decay in the Galactic center. We consider model-independent direct and secondary neutrino production. We also consider specific dark matter models, in which the dark matter particle is a gravitino, a Kaluza-Klein particle and a particle in leptophilic models. We incorporate neutrino oscillations. We evaluate the muon and shower event rates and the minimum observation times in order to reach 2$\sigma$s significance. We illustrate how observation times vary with the cone half angle chosen about the Galactic center, with the result that the optimum angles are about 10$^\circ$ and 50$^\circ$ for the muon events and shower events, respectively. We find that for the annihilating dark matter models such as the leptophilic and Kaluza-Klein models, upward and contained muon as well as showers are promising signals for dark matter detection in just a few years of observation, whereas for decaying dark matter models, the same observation times can only be reached with showers.

Rouzbeh Allahverdi
University of New Mexico
6:45 p.m.-7:15 p.m.

Extracting Dark Matter Parameters from the IceCube

I discuss the prospects for extracting dark matter parameters from the IceCube neutrino telescope. The spectra of muon tracks may be used to distinguish models with different annihilation final states (neutrinos vs gauge bosons, taus and quarks). One may in addition be able to distinguish final states with different neutrino flavors for a dark matter mass in the intermediate range ~200-300 GeV.

Qiang Yuan
IHEP/UNLV
7:15 p.m.-7:30 p.m.

Constraint on dark matter annihilation with dark star formation using Fermi EGRB data

It has been proposed that during the formation of the first stars there might be a "dark star" phase in which the power of the star comes from dark matter annihilation. The formation of the dark star will result in a highly concentrated density profile of the host halo, which may give enhanced indirect detection signals of dark matter. In this work we investigate the extragalactic $\gamma$-ray background from dark matter annihilation with dark star formation, and employ the isotropic $\gamma$-ray data from Fermi-LAT to constrain the model parameters of dark matter. The results suffer from large uncertainties of both the formation rate of the first generation stars and the subsequent evolution effects of the host halos of the dark stars. We find, in the most optimistic case, the expected extragalactic $\gamma$-ray flux will be enhanced by $1-2\sigma$ orders of magnitude. In such a case, the annihilation cross section of the supersymmetric dark matter can be constrained to the thermal production level, and the leptonic dark matter model which is proposed to explain the positron/electron excesses can be well excluded.

Tuesday, February 1, 2011

X-Ray Polarimetry

Organized by: Henric Krawczynski, T. Kallman (NASA Goddard Space Flight Center), M. Baring (Rice University), and J. Schnittman (NASA Goddard Space Flight Center)
X-ray polarimetry has the potential to make substantial contributions to the fields of Particle Physics, Strong Field Gravity, and Astrophysics. The field is expected to move center stage in 2014 when NASA’s Gravity and Extreme Magnetism SMEX (GEMS, Swank et al.) mission will be launched. GEMS will have the sensitivity to probe ~1% level linear polarization in the 2—10 keV band from dozens of different astronomical sources. In this special session we focus on physics topics which can be studied with GEMS and with future X-ray polarimeters: (i) fundamental physics topics, (ii) the physics of neutron stars and stellar mass black holes and their environments, and (iii) the properties of AGN accretion flows and AGN jets.

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<th>Continental Breakfast</th>
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**The Gravity & Extreme Magnetism Small Explorer Mission**

Polarization is an inherently geometric quantity and provides information on source geometry inaccessible via spectroscopy or timing. To date, there have been reliable detections of X-ray polarization from only one object outside the solar system (the Crab nebula). Recent development of photoelectric polarimetry makes it possible to perform sensitive X-ray polarimetry with a modest mission. GEMS was recently selected by NASA to be the 13th Small Explorer mission with launch planned for 2014. GEMS will be ~100× more sensitive than any previously flown X-ray polarimeter and should provide useful polarization measurements for dozens of sources, to lower than predicted levels. GEMS will lead to new insights into the nature of accreting black holes, highly magnetized neutron stars, and supernova remnants.

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<th>Alice Harding</th>
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**X-Ray Polarization Properties of Neutron Stars**

Phase-resolved polarimetry of pulsars has had enormous diagnostic capability at radio and optical wavelengths and could also be a powerful diagnostic in the X-ray range. Measurement of the polarization properties as a function of pulse phase can therefore provide a multidimensional mapping of the pulsar emission and of the magnetosphere. Fermi observations of pulsars strongly favor emission from the outer magnetosphere, for which the standard `rotating vector model used for lower-altitude radio emission does not apply. The polarization will have a more complex signature, as a result of relativistic effects of aberration and time-of-flight delays and may also cause depolarization of the signal. Furthermore, the polarization properties are affected by the magnetic field structure near the light cylinder that is different in retarded vacuum and force-free models. I will discuss predicted polarization properties of pulsed emission in slot gap and outer gap models, where radiation originates over a range of altitudes out to the speed-of-light cylinder, how they depend on the different magnetosphere models and how polarizations measurements may complement Fermi observations.

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<th>Matthew Baring</th>
<th>Rice University</th>
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**Observable Polarization Signatures in the Atmospheres & Magnetospheres of Neutron Stars**

Pulsars and magnetars are among the most powerful compact objects in the stellar mass range observed in the Milky Way. The presence of a strong magnetic field in these classes of neutron stars is a powerful anisotropizing agent. Accordingly, the inherently anisotropic environs of their atmospheres and magnetospheres seeds strongly polarized X-ray emission, whose signatures should be observable with GEMS and future polarimetry initiatives. This talk summarizes some of the expectations for polarization from QED effects operating at or near the neutron star surface, or in the inner magnetosphere. Vacuum polarization, resonant Compton and photon splitting effects are highlighted, all being germane to the classic and hard X-ray bands.

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<tr>
<th>Rodrigo Fernandez</th>
<th>Institute for Advanced Study</th>
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**Probing Magnetar Magnetospheres with X-ray Polarization**

Magnetar candidates are bright X-ray sources. Their quiescent emission in the 1 - 10 keV band is thought to arise from resonant Comptonization of thermal photons in a twisted magnetosphere. I will report on multidimensional radiative transfer calculations that probe the effects of magnetospheric scattering on the X-ray polarization observables. When the pair multiplicity is not too large, propagation eigenmodes remain mostly linear, and the polarization signal carries independent information about surface and magnetospheric radiative processes, directionality of the particle energy distribution, and geometry of the magnetic field at ~100 stellar radii.

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<td>Matthew Mewes</td>
<td>Swarthmore College</td>
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**Tests of Lorentz Invariance Using Astrophysical Sources**
Lorentz invariance is a keystone of modern physics. However, attempts at a theory of quantum gravity suggest that Lorentz invariance may only be an approximate symmetry at low energies. This idea has led to numerous searches for violations of Lorentz symmetry in a variety of systems. Among the most sensitive tests of Lorentz invariance are those based on vacuum birefringence. Birefringence results in a change in the polarization of light as it propagates through empty space. Since this effect usually grows with frequency, polarimetry of high-energy photons is an excellent place to look for Lorentz violation.

Jeffrey Scargle | NASA Ames | 10:20 a.m.-10:45 a.m.

Lorentz Invariance: Results from Astrophysical Observations

I will briefly overview the background for the concept that the chasm between scales measurable in Earth-bound laboratories and the Planck scale at which most quantum-gravity theoreticians believe breaking of Lorentz invariance may occur. Such effects might manifest themselves in a small dispersion (speed of light dependent on photon energy) or others such as a birefringence of direct interest to GEMS. The Fermi Gamma Ray Space Telescope, and other high-energy observations have already led to interesting observational limits on dispersion. I will describe innovative data analysis methods that have been used in this arena, with some ideas about how similar methods might be used for analysis of GEMS data.

Scott Noble | RIT | 10:45 a.m.-11:10 a.m.

MHD Simulations of BH Accretion Disks

Gas accretion onto black holes is thought to power some of the most energetic astrophysical phenomena observed. Black hole accretion disks are efficient engines for converting binding energy into light, and for launching relativistic unbound flows (jets) such as in gamma ray bursts, microquasars and radio-loud active galactic nuclei (AGN). For nearly the past 40 years, the primary theoretical model for radiatively efficient, geometrically thin accretion disks around black holes has been that of Novikov and Thorne. This steady-state model for razor-thin disks has been invaluable for understanding the thermal emission from AGN and X-ray binaries, and has been used to make precise measurements of the spin of several galactic black holes. Unfortunately, the model provides an incomplete picture of a disk’s dynamical variability and assumes that the shear stress vanishes at the innermost stable circular orbit (ISCO). This latter characteristic is often exploited to measure a black hole’s spin, though its applicability to real disks has yet to be sufficiently substantiated (though it was questioned from the beginning). With current supercomputing resources and the maturation of general relativistic magnetohydrodynamics (GRMHD) simulation codes, we can now begin to study dynamical, magnetized thin disks and test this assumption directly. I will describe the efforts of ours and others toward this goal, and present evidence that suggests a modification to this aspect of the model may be needed. Our results imply that thin disks may be even more efficient than initially thought. If time permits, I will also describe how temporal variability analysis of our dynamical simulations can offer insight into the common behavior seen in high-energy emission from black holes of all sizes.

Mid-Day Break | 11:15 a.m.-4:30 p.m.

Shane Davis | CITA | 4:30 p.m.-5:00 p.m.

X-ray Polarization from Magnetized Accretion Disks

Local simulations of accretion flows generate strong, near-equipartition magnetic fields. Radiative transfer calculations show that these fields can have a significant impact on the observed polarization due to Faraday rotation. I will summarize these results and discuss their implications for the polarization of X-ray emission from black hole X-ray binaries.

Jeremy Schnittman | NASA Goddard Space Flight Ctr | 5:00 p.m.-5:30 p.m.

AGN & their Relativistic Outflows

Polarization Constraints on BBH Parameters

In the coming years, new space missions will be able to measure X-ray polarization at levels of 1% or better in the ~1-10 keV energy band. In particular, X-ray polarization is an ideal tool for determining the nature of black hole (BH) accretion disks surrounded by hot coronae. Using a Monte Carlo radiation transport code in full general relativity, we calculate the spectra and polarization features of these BH systems. At low energies, the signal is dominated by the thermal flux coming directly from the optically thick disk. At higher energies, the thermal seed photons have been inverse-Compton scattered by the corona, often reflecting back off the disk before reaching the observer, giving a distinctive polarization signature. By measuring the degree and angle of this X-ray polarization, we can infer the BH inclination, the emission geometry of the accretion flow, and also determine the spin of the black hole.

Martin Elvis | CfA | 5:30 p.m.-6:00 p.m.

The Highly Non-spherical Inner Structures of Active Galactic Nuclei
The structures around the supermassive black holes at the centers of quasars and active galactic nuclei (AGNs) are highly asymmetric. The structures include: linear relativistic jets, an accretion disk, bi-conical winds and possibly warped disks feeding into the accretion disk on larger scales. With an intense, small radiation source near the event horizon spanning the UV to X-ray bands, the opportunities for creating highly polarized radiation from scattering off these non-spherical structures are many. I will describe the several revealing polarimetric observations already existing in AGNs and will consider the possibilities for new observations to tell us more about the intimate environments of quasars.

Herman Marshall | MIT (GEMS collaboration) | 6:00 p.m.-6:30 p.m.

Examining the Core of Centaurus A Using X-ray Polarimetry

At 3.4 Mpc, Centaurus A is the nearest example of an active galaxy with strong radio emission from the core, jet, and lobes. The host galaxy, NGC5128, is a giant elliptical containing a kpc-scale dust lane which obscures the center. Chandra images show that all of these structures emit X-rays and that the total is dominated by the bright core. We show that observations with the upcoming NASA mission, the Gravitation and Extreme Magnetism SMEX (GEMS), will test models of the origin of X-ray emission from the core. On milli-arcsecond scales, as observed using VLBI networks, the pc-scale jet dominates. By measuring the polarization of the core X-rays, GEMS will be able to examine the structure of this small scale jet, unresolved by Chandra.

Coffee Break | 6:30 p.m.-6:45 p.m.

Henric Krawczynski | Wash. Univ., MCSS | 6:45 p.m.-7:15 p.m.

Scientific Drivers of X-Ray Polarimetry Observations of Blazars

The field of X-ray polarimetry has been semi-dormant for several decades owing to the lack of sensitive X-ray polarimetry missions. The situation will change when NASA’s GEMS (Gravity and Extreme Magnetism SMEX) mission will be launched. GEMS will be able to probe percent level polarization degrees of 2-10 keV X-rays for mCrab sources. In this contribution, we describe GEMS observations of blazars. I highlight three GEMS blazar science investigations and their expected scientific pay-off.

Bing Zhang | UN Las Vegas | 7:15 p.m.-7:45 p.m.

Gamma-Ray Burst Polarization

Depending on jet composition, radiation mechanism, and viewing geometry, prompt gamma-ray emission of some or even all GRBs could be linearly polarized. Models of GRB polarization are reviewed. Prospects of using polarization data to diagnose GRB physics are discussed.

Wednesday, February 2, 2011

**Ultra High Energy Cosmic Rays**

Organized by: Gordon Thomson

Wednesday’s sessions will be devoted to the physics of ultra high-energy cosmic rays. The latest experimental results will be presented, plus theoretical interpretations, and reports from R&D projects on new cosmic ray detection techniques.

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<td>John Horton</td>
<td>Colorado State University</td>
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Recent Results from the Pierre Auger Observatory

The Auger Observatory is operating in western Argentina gathering data on the highest energy particles in the Universe. The presentation will cover the basics of the operation of the two main subsystems of the observatory, the 1600 water Cerenkov units of the surface detector and the 27 telescopes of the fluorescence detector. Physics results will include the energy spectrum, arrival directions, composition of the cosmic rays, and limits on primary photons and neutrinos.

Charlie Jui | University of Utah | 8:35 a.m.-9:10 a.m.

NO TITLE SUBMITTED

NO ABSTRACT SUBMITTED

John Matthews | University of Utah | 9:10 a.m.-9:45 a.m.

First Results from the Telescope Array
The Telescope Array is the largest cosmic ray detector in the northern hemisphere. Originally forged by the High Resolution Fly’s Eye (HiRes) and AGASA groups, the Telescope Array collaboration utilizes both fluorescence and scintillator detectors to study the origin and nature of ultra high energy cosmic rays. The first measurements from this detector will be presented.

Coffee Break
9:45 a.m.-10:00 a.m.

Yuichiro Tameda
University of Tokyo
10:00 a.m.-10:35 a.m.

Measurement of UHECR Composition by TA FD

The Telescope Array is a hybrid detector consisting of Fluorescence Detectors (FDs) and Surface Detectors (SDs) to observe Ultra High Energy Cosmic Rays (UHECRs). FDs are telescopes which can observe longitudinal developments of cosmic-ray air shower which strongly depend on their primary particle types. Especially Xmax is one of the most efficient parameter of shower development for cosmic-ray primary particle type. In this talk, I will present the analysis framework for TA FD and the recent result of measurement of UHECR composition by TA FD stereo events.

Charles Dermer
Naval Research Laboratory
10:35 a.m.-11:10 a.m.

Gamma-Ray Evidence for UHECR Acceleration by FR1 Radio Galaxies & BL Lac Objects

I compare and contrast GRB and AGN hypotheses for UHECR origin, concluding in favor of the latter. Important details remain to be worked out, as outlined in the talk.

Mid-Day Break
11:10am-4:30 pm

Konstantin Belov
UCLA
4:30 p.m.-5:05 p.m.

Ultra High Energy Cosmic Rays Detected by the ANITA Balloon Radio Interferometer

The ANtarctic Impulsive Transient Antenna (ANITA) balloon-borne experiment has completed two successful flights around the Antarctic continent in search of coherent radio pulses from the ice sheet that are a signature of the ultra-high energy (UHE) neutrino interactions. The in depth analysis of the data from the 2006-2007 season flight not only established the new limit on the UHE neutrino flux, but also revealed a sample of 16 UHE cosmic ray (UHECR) events. The ANITA sample is the first measurement of the UHECR geosynchrotron radio emission in a broadband frequency range from 200 to 1200 MHz. It is also the first data sample collected in the far-field as well as the first sample collected by a self-triggered experiment. We present the instrument design, the analysis technique and discuss the primary particle energy estimation and other properties of the ANITA CR sample.

Paolo Privitera
University of Chicago
5:05 p.m.-5:40 p.m.

Tuning the Radio to Ultra-High Energy Cosmic Rays

A novel detection technique for Ultra-High Energy Cosmic Rays (UHECRs) based on microwave emission from the air plasma produced by the cosmic ray shower in the atmosphere, brings great promise. Microwave signals from UHECRs are minimally attenuated by the atmosphere, even in presence of clouds or rain, and are detectable day and night, allowing for large area coverage at low cost. Imaging the cosmic ray shower with a pixelized camera provides the unique advantages of the fluorescence detection technique – calorimetric energy measurement and reconstruction of shower maximum development - without the drawbacks of UV light detection, which is limited to moonless nights and requires ancillary instruments for accurate atmospheric monitoring. I will present the status and first results of the MIDAS (Microwave Detection of Air Showers) detector, a large field-of-view antenna currently installed at the University of Chicago. MIDAS, together with the other microwave detectors AMBER and EASIER, will be soon installed at the Pierre Auger Observatory in Argentina for coincident detection of UHECRs.

Helio Takai
Brookhaven National Laboratory
5:40 p.m.-6:15 p.m.

Forward Scattering Radar for Ultra High Energy Cosmic Ray Detection

The concept of using a radar for the detection of cosmic ray showers was first introduced in 1941 by Blackett and Lovell. The very first concept was to simply use a ranging radar to locate and measure the properties of a cosmic ray induced shower. This concept has been examined over the years and it has been established that it can work under very special conditions. A second type of radar, the forward scattering radar, may be more appropriate for the detection of cosmic ray showers. Introduced in mid 40’s and developed in the 50’s this type of radar takes advantage of the large signal enhancement at forward direction to detect small objects. We will present an analysis of how a forward scattering radar may work for the detection of cosmic ray showers, and describe an on going effort to implement a radar at the telescope array site.

Coffee Break
6:15 p.m.-6:30 p.m.

Rasha Abbasi
University of Wisconsin
6:30 p.m.-7:05 p.m.

Evolution of the cosmic ray anisotropy above 100 TeV as Observed by IceCube
IceCube is a one kilometer-cubed neutrino observatory located at the geographical South Pole. The IceCube detector construction is now completed with 86 strings, including six strings for the low energy Deep Core array. The strings are deployed in the deep ice at a depth range between 1,450 and 2,450 meters, with each string containing 60 optical sensors, equally spaced.

In this talk I will present selected results of on-going analyses of the IceCube detector data, including presenting an update on the measurement of the cosmic ray anisotropy. The data used in the anisotropy analysis comprises 23 billion downward moving muon events with a median energy per nucleon of ~20 TeV and a median angular resolution of 3 degrees. The energy dependence of the anisotropy at 400 TeV is also presented. The results are supported by the observation of the solar diurnal anisotropy expected from the revolution of the Earth around the Sun. They are also supported by the absence of the signal in the anti-sidereal time. Studies of the anisotropy energy dependence could further enhance the understanding of the structure of the galactic magnetic field and possible cosmic ray sources.

Todor Stanev
University of Delaware
7:05 p.m.-7:40 p.m.

NO TITLE SUBMITTED
NO ABSTRACT SUBMITTED

Thursday, February 3, 2011

Multi-Messenger AGN

Organized by: Alex Kusenko

Multi-messenger, multi-wavelength studies of active galactic nuclei (AGN) have produced invaluable insights into the nature of the most powerful sources in the universe, as well as the universal photon backgrounds, cosmic rays, and intergalactic magnetic fields. The special session on AGN will bring together theorists and observers from different areas of astrophysics relevant to AGN and high energy astrophysics, to further synergy in this exciting multidisciplinary field of research.

Continental Breakfast
7:00 a.m. - 8:30 a.m.

Dan Evans
Harvard-Smithsonian CfA & Elon University
8:00 a.m.-8:30 a.m.

Do AGN Outflows Cease Star Formation? A New Technique Based on Ultradeep Chandra HETG Observations of Nearby AGN

AGN outflows are widely invoked as the key mediators between the co-evolution of black holes and their host galaxies. Yet, the key question remains: do the outflows actually deliver enough power to their environments to alter evolution in a meaningful way? To address this, we present results from a the Chandra SOARS (Survey Outflows in AGN with Resolved Spectroscopy) program: a series of ultradeep Chandra HETG observations of the kpc-scale ionization cones in nearby Seyfert 2 AGN. We perform the first spatially resolved, sub-arcsecond scale, high-resolution X-ray spectroscopy of an AGN environment in NGC 1068, and use the sensitive line diagnostics offered by HETG to measure the outflow rate, ionization state, density, and temperature at discrete points along the ionized NLR. Our results have key implications for the role of galactic-scale outflows in AGN as modulators of galaxy evolution, and may suggest that outflows have radically different properties in early- and late-type AGN.

Jordan Goodman
University of Maryland
8:35 a.m.-9:05 a.m.

AGN With HAWC

The High Altitude Water Cherenkov observatory (HAWC) is a wide-field, continuously-operating TeV gamma ray detector under construction at a 4100 m asl site near the Volcán Sierra Negra, Mexico. When completed, HAWC will be about 15 times more sensitive than its predecessor Milagro and will have significant sensitivity to gamma rays above ~50 GeV. This combination of low threshold and daily monitoring will make HAWC an ideal instrument to participate in multi-wavelength campaigns of AGNs. In this talk the status and design of HAWC, as well as, the physics reach of HAWC will be presented.

Coffee Break
9:10 a.m.-9:25 a.m.

Warren Essey
UCLA
9:25 a.m.-9:55 a.m.

Secondary Photons & Neutrinos From Distant Blazars & The Intergalactic Magnetic Fields
Secondary photons and neutrinos produced in the interactions of cosmic ray protons and gamma rays emitted by distant Active Galactic Nuclei (AGN) with the photon background along the line of sight can reveal a wealth of new information about the intergalactic magnetic fields (IGMF), extragalactic background light (EBL), and the acceleration mechanisms of cosmic rays. The secondary photons may have already been observed by gamma-ray telescopes. With the inclusion of secondary photons the current upper limits on the extragalactic background light are significantly weakened and new limits are set for the intergalactic magnetic fields for a wide range of cosmic ray and gamma ray models. The secondary neutrinos also improve the prospects of discovering distant blazars by IceCube. Ramifications for the cosmic backgrounds, magnetic fields, and AGN models will be discussed.

Shin'ichiro Ando

10:00 a.m.-10:30 a.m.

Search for Gamma-Ray Halos Around Fermi AGNs

Intergalactic magnetic fields (IGMF) can cause the appearance of halos around the gamma-ray images of distant objects because an electromagnetic cascade initiated by a high-energy gamma-ray interaction with the photon background is broadened by magnetic deflections. In this talk, I report evidence of such gamma-ray halos in the stacked images of the 170 brightest active galactic nuclei (AGNs) in the 11-month source catalog of the Fermi Gamma-Ray Space Telescope. Excess over point spread function in the surface brightness profile is statistically significant, for the nearby, hard population of AGNs. The halo size and brightness are consistent with IGMF, B \approx 10^{-15} G. The knowledge of IGMF will facilitate the future gamma-ray and charged-particle astronomy. Furthermore, since IGMF are likely to originate from the primordial seed fields created shortly after the Big Bang, this potentially opens a new window on the origin of cosmological magnetic fields, inflation, and the phase transitions in the early Universe.

Mid-Day Break

10:35 am-4:25 pm

Kohta Murase

CCAPP, OSU

4:30 p.m.-5:00 p.m.

High-Energy Particle Emission from AGN Embedded in the Cosmic Web

Active galactic nucleus (AGN) is one of the most powerful astrophysical objects in the Universe, and AGN may be accelerators of very high-energy and/or ultrahigh-energy (UHE) cosmic rays. AGN are typically located in the structured region of the Universe, clusters and filaments, and we will discuss its implications in my talk. Cosmic rays are deflected and trapped, which also cause significant time delays. Also, diffusing cosmic rays lead to production of neutrino and gamma rays especially in the clusters, which may be detectable by future telescopes. On the other hand, high-energy gamma rays and neutrinos produced in jets escape from the structured region, which can lead to different signals such as pair halo/echo emission. We will also discuss implications of UHE cosmic-ray nuclei sources, motivated by the recent PAO results.

Nicola Galante

Harvard-Smithsonian CfA

5:05 p.m.-5:35 p.m.

High-Energy Particle Emission from AGN Embedded in the Cosmic Web

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Coffee Break

5:40 p.m.-5:55 p.m.

Shunsaku Horiuchi

Ohio State

5:55 p.m.-6:25 p.m.

Sources & Signatures of Heavy Nuclei UHECR

Recent results from the Pierre Auger Observatory show that the composition of ultra-high energy cosmic rays (UHECR) becomes increasingly heavier on average with energy. We discuss potential sources of UHECR in light of these results. We also discuss signatures of nuclei UHECR in gamma rays and neutrinos. Finally, we discuss how models of some GRBs naturally predict UHECRs that can even dominate by very heavy nuclei.

Antoine Calvez

UCLA

6:30 p.m.-7:00 p.m.

The Role of Galactic Sources & Magnetic Fields in Forming the Observed Energy-Dependent Composition of Ultrahigh-Energy Cosmic Rays

Recent results from the Pierre Auger Observatory show an energy dependent chemical composition of ultrahigh-energy cosmic rays (UHECRs), with a growing fraction of heavy elements at high energies. These results suggest a possible non-negligible contribution from galactic sources. We show that in the case of UHECRs produced by gamma-ray bursts (GRBs), or by rare types of supernova explosions that took place in the Milky Way in the past; the change in the composition of the UHECRs can be the result of the difference in diffusion times between different species. The anisotropy in the direction of the Galactic Center is expected to be a few per cent on average, and the locations of the most recent/closest bursts can be associated with observed clustering of UHECRs.
**Banquet**  
8:00 p.m. - 10:30 p.m.

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**Friday, February 4, 2011**

### Cosmology

**Organized by:** Kyle Dawson

While the fundamental nature of dark matter and dark energy remain elusive, recent studies have revealed ever more distant galaxies and surprising details about the abundance of massive objects at high redshift. Simulations, theory, and large surveys promise to bring new insight to our understanding of large scale structure, galaxy evolution, and the formation of the first galaxies. This session will include talks describing recent developments in the field of high redshift cosmology and galaxy evolution.

#### Continental Breakfast

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| 7:00 a.m. - 8:30 a.m. | University of Minnesota  

#### Results from VERITAS Observations of Clusters of Galaxies

Clusters of galaxies are the largest observed structures in the Universe. They contain large amounts of dark matter but also significant amount of baryonic matter in the intra-cluster medium (ICM). This gas provides target material for highly relativistic cosmic rays to produce gamma rays. A detection of gamma-ray emission from a galaxy cluster provide a detailed understanding of the morphology of non-thermal particles and fields in a cluster. The VERITAS array of four 12 meter diameter imaging atmospheric Cherenkov telescopes is in prime position for detection of VHE gamma ray from a cluster. The nearby, very rich Coma cluster in the northern hemisphere was targeted by VERITAS during the 2007-2008 season. In this talk I will discuss these observations and results from them and put them in a cosmological context.

#### Coffee Break

9:30 a.m.-9:45 a.m.

#### Galaxy Clusters in Optical Band: from SDSS to Dark Energy Survey

Galaxy clusters detected from optical data play important roles in cluster cosmology. I am going to introduce our efforts from galaxy cluster detection to mass calibration and then to cluster cosmology based on SDSS data. Based on the experience we gained from SDSS data, I will introduce what we (cluster working group) are doing now for the Dark Energy Survey based on simulation.

#### Astrophysical Uncertainty in the Sunyaev-Zel'dovich Power Spectrum

Recent measurements of the Sunyaev-Zel'dovich (SZ) power spectrum by South Pole Telescope and Atacama Cosmology Telescope revealed that the SZ power is significantly below the signal predicted by the model of cosmic structure formation. In this talk, I will show that the current SZ power spectrum template has over-predicted the signal by 100%, primarily because the model has neglected an important astrophysical process: gas motions in the outskirts of high-redshift groups and clusters. I will present a new model that take into account the effects of gas motions and show that it can reduce the tension between the value of sigma_8 measured from the SZ power spectrum and from cluster abundances. In the last few minutes, I will discuss the prospect of measuring gas motions in groups and clusters using the upcoming Astro-H mission.

#### Improved Constraints on CMB Secondary Anisotropies from the Complete 2008 South Pole Telescope Data

In 2008, the South Pole Telescope observed two hundred square-degrees at 150 and 220 GHz. These data have been analyzed using a cross-spectrum analysis to produce bandpowers in the range 2000 < \ell < 9500. We fit these bandpowers using a multi-frequency Markov Chain Monte Carlo routine with a model that includes lensed primary CMB anisotropy, secondary thermal (tSZ) and kinetic (ksz) Sunyaev-Del'dovich anisotropies, unclustered synchrotron point sources, and clustered dusty point sources. In addition to measuring the power spectrum of dusty galaxies at high signal-to-noise, these data primarily constrain a linear combination of the tSZ and kSZ anisotropy contributions, and allow for significantly improved upper limits on each. This result increases the significance of the detection of less ISZ power than recent models predict. We will present these results, and discuss the implications for cluster models and constraints on cosmological parameters.
## Massive z > 1 Clusters from the South Pole Telescope Cluster Survey

The South Pole Telescope cluster survey is detecting massive clusters out to high redshift --- a sample of particular cosmological and astrophysical interest. A catalog of 21 clusters uniformly selected by Sunyaev-Zel'dovich signal-to-noise ratio from its first 180 deg² was released in early 2010. Twelve of these were previously unknown, with 3 at $z \geq 1$ and the most distant, spectroscopically confirmed cluster at $z = 1.07$. In the first week of 2011, the SPT team released another catalog of 26 clusters from 2500 deg², uniformly selected with a higher effective S/N threshold. Again, 12 were previously unknown, with 2 new clusters at $z = 1$. The most distant, spectroscopically confirmed cluster was SPT-CL J2106-5844 at $z = 1.13$. With an $M_{200} = 1.3e15$ Msun/h70, determined jointly from the SZ S/N, $Y_X$ from 25 ks of Chandra observations, and velocity dispersion measurements from 18 member galaxies from VLT and Magellan observations, this is now the most massive z > 1 cluster known. While this sample contains multiple clusters whose mass and redshift are at the extremes of the known cluster population, we nevertheless find that the mass and redshift distribution of the sample is consistent with Lambda-CDM concordance cosmology and Gaussian initial matter perturbations.

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<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Institution</th>
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<tr>
<td>11:00 a.m.</td>
<td>Joel Brownstein</td>
<td>University of Utah</td>
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<td>5:40 p.m.</td>
<td>Oleg Gnedin</td>
<td>University of Michigan</td>
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<td>5:05 p.m.</td>
<td>Chris Kochanek</td>
<td>The Ohio State University</td>
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<td>4:30 p.m.</td>
<td>Daniel Whalen</td>
<td>Carnegie Mellon University</td>
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<tr>
<td>7:05 p.m.</td>
<td>William High</td>
<td>KICP - University of Chicago</td>
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### Gravitational Lensing Constraints on Structure Formation Problems

Gravitational lensing provides a uniquely extraordinary tool for probing the internal structure of galaxies and clusters, and is a vital compliment to photometric galaxy rotation curve measurements and X-ray cluster imaging. Precise measurements of the distribution of matter in galaxies and clusters of galaxies is essential to resolving the structure formation problem. Whereas hydrodynamical simulations are now advancing to include dynamical and baryonic processes, there remain a number of observational inconsistencies to be resolved. Fortunately, ongoing advancement in gravitational lensing methodologies has made possible measurements of the mass function at small, sub-galactic scales by directly observing perturbations in the gravitational potential. The continuing Sloan Lens ACS (SLACS) survey and the deeper redshift BOSS Emission Line Lensing Survey (BELLS) comprise a sample of over 100 strong galaxy lenses, from which we are measuring the dark matter fraction, and revealing the crucial role played by baryons in the formation of galactic structure.

### Formation of High-Redshift Galaxies

I will discuss new ultra-high-resolution hydrodynamic cosmological simulations of $z > 2$ galaxies. As a result of gas cooling, dark matter halo profiles become more centrally concentrated, compared to N-body simulations. Star formation takes place only in molecular clouds, mostly in the inner region of galaxies. The first galaxies are significantly smaller in size than their low-redshift counterparts.

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<td>Daniel Whalen</td>
<td>Carnegie Mellon University</td>
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### Finding the First Cosmic Explosions

The first stars in the universe are key to primeval galaxy formation, early cosmological reionization and the origin of supermassive black holes. Unfortunately, because they were born near the edge of the observable universe, Pop III stars lie beyond the reach of current instruments. However, their supernovae may be visible to JWST and the next generation of thirty-meter class telescopes. We have performed radiation hydrodynamical calculations of the observational signatures of the first cosmic explosions. Our results indicate that Pop III SNe will be observable by JWST out to $z \sim 15$, and possibly to $z \sim 20$ with gravitational lensing. Our models also reveal that early spectrometry of the explosion after initial shock breakout pulse is the key to determining the mass of the progenitor, and hence the first estimates of the Pop III IMF.

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## Last updated: Tuesday, January 25, 2011
# Research Within the State of Utah

**Organized by:** Paolo Gondolo & Dave Kieda

This session is designed to share the broad range of science pursued by astronomers and astrophysicists across the state of Utah. In the morning, researchers from around the state will present their recent work in research and education. The afternoon and evening will be set aside for informal discussions and brainstorming about future research and outreach efforts in Utah.

<table>
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<th>Time</th>
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<tr>
<td><strong>7:00 a.m.</strong></td>
<td>Continental Breakfast</td>
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<td><strong>8:00 a.m.</strong></td>
<td>Karl F. Warnick &amp; Brian D. Jeffs Brigham Young University</td>
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<tr>
<td>8:00 a.m.-8:20 a.m.</td>
<td><strong>Progress in Phased Array Feeds for Wide-Field Radio Astronomical Observations at Brigham Young University</strong></td>
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<td><strong>8:20 a.m.</strong></td>
<td>J. Ward Moody Brigham Young University</td>
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<td><strong>8:40 a.m.</strong></td>
<td>Monitoring Variable Objects with ROVOR</td>
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<tr>
<td><strong>9:00 a.m.</strong></td>
<td>Machine Gun Presentations &amp; Discussions</td>
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<td><strong>9:45 a.m.</strong></td>
<td>Coffee Break</td>
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<td><strong>10:00 a.m.</strong></td>
<td>Joseph Jensen Utah Valley University</td>
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## Progress in Phased Array Feeds for Wide-Field Radio Astronomical Observations at Brigham Young University

The radio astronomy community is transitioning from single feed antennas to a new generation of instruments based on phased array technology. Major international development efforts include multi-pixel phased array feeds for large reflectors, low frequency aperture arrays such as LOFAR in the Netherlands, and the Square Kilometer Array (SKA). These instruments will have a significantly larger field of view than conventional single-pixel telescopes. Wide field instruments will enable fundamentally new astronomical observations such as rapid sky surveys and radio transient searches. Phased array feeds also allow electronic beam pattern control and adaptive interference mitigation to cancel manmade radio signals that would otherwise obscure extremely weak deep space sources. This presentation will survey recent developments on phased array feeds at Brigham Young University, including impedance matching and noise minimization for active arrays, measurement techniques for system noise and efficiencies, calibration methods, and stable beamforming algorithms. Experimental results for the BYU/NRAO L-band Phased Array Feed on the Green Bank 20-Meter Telescope will be shown, including some of the first radio images produced with a phased array.

## The Future of Utah Astronomy: One Man’s Wish

Astronomy in Utah is as healthy as it has ever been and, more importantly, is poised to make great strides in the near future. In this presentation I lay out the case for bolstering Utah astronomy by building a 3-4 meter class telescope in Utah through a multi-institutional organization. Such a telescope needs to be supported by novel instrumentation and adequate staff. It must have both a clearly defined scientific niche and be a benefit to the programs of all institutions. I present my thoughts on this in hopes of generating discussion and ideas.

## Monitoring Variable Objects with ROVOR

The Remote Observatory for Variable Object Research (ROVOR) is a 16” RC Optical telescope sited 12 miles NW of Delta Utah. It has been built to remotely monitor bright objects that vary with time such as variable stars, cataclysmic variables, GRBs, and active galactic nuclei (AGN) including blazars, quasars, Seyfert nuclei and Low Ionization Nuclear Emission Regions (LINERS). ROVOR has been designed from the ground up with off the shelf materials, making it a cost effective solution to modern astronomical research. Observatory communication and control on ROVOR is provided through a Java software package called CelestialGrid. CelestialGrid was entirely built at BYU and is an all-inclusive observatory system which automates the capture, retrieval, calibration, reduction, and long-term archival of astronomical data. CelestialGrid is a software framework built on top of Software Bisque Orchestrate, The Sky, and CCDSoft for telescope operation, and LabVIEW for dome operation. Although CelestialGrid was developed for use on ROVOR, the system is modular and is capable of controlling many different observatories. I will present the capabilities and demonstrate the operation of CelestialGrid.

## Measuring Extragalactic Distances Using Infrared Surface Brightness Fluctuations

Distance measurements are key to our understanding the nature and contents of the universe. Improvements in distance measurement techniques made possible the discovery of dark energy and yielded a model of the universe that is consistent with fundamental physics and astronomical observations for the first time. One distance measurement tool, known as “surface brightness fluctuations,” is particularly accurate and useful, not just for measuring distances, but also for probing the unresolved stellar populations of distant galaxies. I will describe how the technique works and how it will be possible to measure fluctuations in much more distant galaxies in the near future.
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<tr>
<th>James Chisholm</th>
<th>Southern Utah University</th>
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<tr>
<td>Tuning/Black Holes</td>
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<td>In keeping with the “Research and Education” aspect of this session, my talk will include two short talks on each subject. 1) For Education: The Tuning USA Process was a pilot project with the goal of defining and clarifying undergraduate and graduate degree standards in various fields across the country. In collaboration with the Utah Board of Regents, physics faculty from Utah public institutions participated in this process in March - November 2009. As a member of the Utah Physics Working Group, I will give my perspectives on this project and how it might be beneficial on a national scale. 2) For Research: Primordial black holes (PBHs) would be created with a high degree of spatial clustering. One consequence of this is the formation of bound PBH clusters. The evolution of these systems will be discussed, with a focus on the possibility that runaway collapse of these systems could provide the seeds of supermassive black holes at the centers of galaxies.</td>
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<th>Denise Stephens</th>
<th>Brigham Young University</th>
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<td>Identifying Unresolved Binary Systems in Hubble Space Telescope Data</td>
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<td>While ground based telescopes are getting ever better resolution due to the advanced technologies of adaptive optics, the Hubble Space Telescope (HST) still has the one advantage that its point spread function is always the same no matter the time of year, the atmospheric conditions, etc. This is an ideal situation when looking at binary systems that are marginally or completely unresolved. The stability of the point spread function (PSF) means that we can easily create a very accurate model of the PSF. We can then model and discover marginally or unresolved binary systems in our data by taking two model PSFs and varying their position and their amplitude until they match the unresolved binary observed in our data. By so doing, we are able to find binary systems in our data sets that would never be identified by eye, and calculate approximate separations and position angles for the two objects. Using this technique we were able to find six new binary Trans-Neptunian objects, a few of which were followed up with further observations to determine their orbital properties and system masses. We are now applying these same techniques to discover unresolved binary brown dwarf systems in archival HST data. So far we’ve only examined ten brown dwarf systems, but we have already found two previously unknown binary systems among those ten objects. In this talk, I’ll highlight the technique we are using to identify binary brown dwarf systems, our results for one of the newly discovered binaries as an example, and talk about why it is important to identify these binary systems.</td>
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<th>Victor Migenes</th>
<th>Brigham Young University</th>
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<td>Multi-frequency observations of the galaxy-merging system II Zw096</td>
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<td>We present the results from OH MASER observations, with the MERLIN radio array, and optical B, V, R, I and Halpha observations, with the 1.5m telescope in San Pedro Mártir, of the nearby starburst &quot;galaxy&quot; II Zw096. The results are discussed in combination with IR observations published in the literature using the NICMOS camera of the HST. Our data suggests the possibility for the presence of an AGN in the system. Consequently, although the OH Megamaser emission was previously suspected to be of starburst origin it is possible that it is associated with the AGN. We propose that considering all the evidence, so far II Zw096 is a &quot;composite&quot; source.</td>
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| Open Discussion | | 11:20 a.m. – 6:00 p.m. |